

WHO'S THE BOSS IN THE NUCLEUS?

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1. Introduction

It is a well-known fact that languages tend to avoid vowels in hiatus. According to Bell and Hooper (1978:8), 'VV sequences (hiatus) are not permitted by about one half of the world's languages'. However, when vowel sequences do occur as a result of the deletion of a consonantal segment, or, the concatenation of morphemes, a language has to find a way to eliminate bad syllable contact.

There are several ways of eliminating sonority clash. First, as shown in 1, a consonantal segment is inserted in-between the vocalic elements:

- (1) *bela* > *biela* > *bi[j]ela* 'white' (Serbo-Croatian)
 echo + *en* > *echo[w]en* 'echo' (Dutch)

Another way to avoid sonority clash is to delete either one of the vocalic segments as in 2:

- (2) *kalcontes* > *kal[ϕ]ontes* 'the calling one' (Greek)
 neaplais > *n[ϕ]aplais* '(he) will not leave' (Baltic)

A third option is to change either one of the vocalic segments into a consonantal segment as depicted in 3:

- (3) *buono* > *b[w]ono* 'good' (Italian)
 iacet > *[j]aze* 'he lies' (VL > Old Spanish)

The examples in 1 through 3 show some ways in which a language can resolve sonority clash. But what interests us most here are the examples given in 4 concerning coalescence.

- (4) *na* + *inkosi* > *n[ɛ]nkosi* 'and the chief' (Zulu)
 sugoi > *sug[ee]* 'terrible, terrific' (Japanese)

Coalescence, or fusion, is defined as the mutual assimilation of pairs of adjacent sounds. Since it is "mutual", both input vowels are assumed to contribute to deriving

the output. However, the same inputs do not always derive the same outputs. For example, in the following examples, the same inputs derive different outputs:

- (5) aurum > [ɔ:]ro 'gold' (Cornish)
ausadha > [o]sadha 'herbs' (Skt. > Pali)

It seems, therefore, natural to assume that some kind of asymmetric relationship exists between the input vowels. How can the outputs be derived? This will be the main focus of our paper.

2. Review of previous studies

According to Foley 1977, the deletion of segments depends on the relative strength of the relevant segments. This means that as a general tendency, the more sonorous a segment is, the more likely it will be preserved. Therefore, in the case of vowel sequences, the vowel subject to deletion will be the "weaker" of the two. The examples in 6 taken from Foley (1977: 46), all show this to be true: the stronger element will remain intact while its weaker counterpart deletes:

- (6) mu + arési > marési
se + aɣapó > saɣapó
to + áloɣo > táloɣo

As we see in 7, however, empirical evidence against this view is not difficult to find:

- (7) tima + omen > tim[ɔ:]men 'honor' (Greek)
re + a > r[ɛ:] 'defendant' (Old Portuguese)

It is clear that coalescence cannot be accounted for by the use of just the sonority scale. Other factors must be taken into consideration. One of the crucial factors involves the notion of "dominancy". The following two studies incorporate the notion of dominancy in dealing with hiatus.

2.1. Schein and Steriade 1986

Schein and Steriade have formulated a contraction rule whereby the place features of vowel sequences become associated with the root node of the first input vowel. They assume that the left element of the nucleus is the dominant factor. "Place features of V_1V_2 become associated exclusively with the root node of V_1 " (Schein and Steriade 1986: 703). The examples in 8, however, show cases where the place features of the output are not associated with the first input vowel.

- (8) klou > kl[u] 'nail' (Old French)
 aydo + a > ayd[ɔ:] 'shame' (Greek)

If we take a look at the second example in 8, the left input vowel /o/ has the features [+back, -high, -low] for its place features, but the output vowel /ɔ/ has [+back, -high, +low]. The lowness does not match, which shows that their contraction rule seems to be too strong in dealing with some of the facts.

2.2. de Haas 1988

In de Haas 1988, vowel coalescence is assumed to be bidirectional. Since coalescence can be defined as the mutual assimilation of the input vowels, de Haas' account of coalescence as being a bidirectional process seems to be on the right track. However, we face some problems when dealing with examples such as those in 5 repeated here as 9:

- (9) aurum > [ɔ:]ro 'gold' (Cornish)
 ausadha > [o]sadha 'herbs' (Skt. > Pali)

As we have already mentioned above, the input vowels are the same, yet, the derived output differs in the Cornish and Pali examples.

Since de Haas assumes the theory of underspecification, this problem can be dealt with by assuming that different features are specified lexically for each language. This would account for the difference observed in 9. However, in some languages, the same inputs, when differing in their order, come out as different outputs. As we will see below, Old Japanese is one such language where the inputs derive different outputs when the orders differ. Unless we assume some kind of dominant, non-dominant relationships in the position of the inputs, there is no accounting for such cases.

So far, the studies dealing with coalescence have not succeeded in giving a good account of what is going on in this process. What measures could be taken in order to capture this phenomenon in a better way?

For a start, let us consider the internal composition of a sound. Clearly the mechanism of a process depends greatly on the internal make-up of sounds.

3. Framework and analysis

3.1. Privativeness and equipollence

This section draws heavily on Harris 1994. Sounds are assumed to be made up of smaller components. The properties assumed for these components differ among theories.

Some theories claim that sounds are based on privative oppositions (a segment either possesses a certain prime or not) whereas others posit equipollent oppositions (the values of a prime are expressed in terms of plus versus minus).

At a glance, the distinction between privativeness and equipollence may not seem to result in much difference. However, when we consider their potential for restricting the set of possible processes that can occur, the two approaches vary greatly. For example, rounding is observed to be a dominant characteristic in coalescence. If a theory assumes both [+round], [-round] underlyingly (based on full specification), then there is no way of preventing [-round] to become the dominant feature even though [+round] should be the actively dominant feature in this process.

By incorporating the underspecification theory, it might be claimed that the dominance of [+round] can well be accounted for. The problem with underspecification, however, is that it has the potential for overriding the universal markedness conventions. That is, a language in question can freely select the dominant underlying features. Thus being the case, if [+round] is specified as the dominant feature underlyingly, it may be possible to account for its active participation in coalescence, yet, the set of possible processes that are allowed by the theory still remains large.

In a theory based upon privative oppositions, a segment either possesses a prime that represents roundness or it lacks it. If it is assumed that only the class possessing the prime [round] can participate in vowel coalescence, then there can in no way exist a complementary process involving the class which does not possess that prime. This greatly reduces the set of possible outputs derived by the process. For this reason, privative oppositions should be favored over equipollent ones.

3.2. Elements, heads, and operators

In recent versions of the government theory, sounds are claimed to be made up of primes that are " 'small' enough to fit inside a segment and yet 'big' enough to enjoy stand-alone phonetic interpretability " (Harris 1994: 96). "Elements", as they are called, are cognitive categories that constitute templates allowing listeners to decode auditory input and speakers to orchestrate and monitor their articulations.

Elements will be the basic phonological unit that will be proposed here. In Harris and Lindsey 1995, the internal elemental patterns are specified as being displayed in a frame resembling a spectral slice. This seems to be the most convincing version in describing each element presented so far. However, it is not yet clear at present what the characteristics of each element really are.

Just for the sake of convenience, following Kaye, Lowenstamm and Vergnaud 1985, let us employ fully specified feature matrices with plus minus values. Although we favor the spectral approach to elements, depicting each element with fully specified feature matrices allows us to better capture the role of the "operator" and "head", which will be crucial to our analysis.

(10) Elements

$\begin{bmatrix} - \text{round} \\ +\text{back} \\ - \text{HIGH} \\ +\text{low} \end{bmatrix}$	$\begin{bmatrix} - \text{round} \\ -\text{BACK} \\ +\text{high} \\ - \text{low} \end{bmatrix}$	$\begin{bmatrix} +\text{ROUND} \\ +\text{back} \\ +\text{high} \\ -\text{low} \end{bmatrix}$
A	I	U

In 10, we have the three basic elements A, I, U. The "features" shown in the uppercase are the marked values for each element. It should be noted again, that although we are employing features based on equipollent oppositions for representing the elements, this does not mean that we are assuming the traditional viewpoint based on the plus and minus values for each prime. As mentioned earlier, representing each element with a fully specified feature matrix is just for convenience' sake. The fundamental phonological unit that is proposed is a higher level prime than the feature. See Harris 1994 for details on the advantages to this approach.

Segments may consist of a single element or combinations of elements. The primitive elements A, I, U would be the elements that independently stand for the segments /a/, /i/, /u/. "Compound vowels" can be generated by combining the primitive elements. "Fusion" as it is called, can be represented by the symbol (·) .

The fusion process works as follows: the input to fusion consists of an "operator" and a "head" . The "operator" contributes only its marked feature value, and the "head" contributes all other features. In 11, an example of the fusion operation is shown:

(11)	OPERATOR		HEAD		
	$\begin{bmatrix} - \text{round} \\ +\text{back} \\ -\text{HIGH} \\ +\text{low} \end{bmatrix}$	·	$\begin{bmatrix} +\text{ROUND} \\ +\text{back} \\ +\text{high} \\ -\text{low} \end{bmatrix}$	>	$\begin{bmatrix} +\text{round} \\ +\text{back} \\ -\text{high} \\ -\text{low} \end{bmatrix}$
	A		U		/o/

The resulting matrix in 11 has all the feature values of the head but one: the marked feature value of the operator. The computation of a matrix, therefore, is carried out by fusing the one marked feature specification of the operator with the remaining feature values of the head.

An important point that should be noted here is that this fusion operation is asymmetric; that is, the same inputs do not necessarily derive the same outputs. The position that the element occupies is crucial in determining the output. For example, $(A \cdot U)$ is not equivalent to $(U \cdot A)$:

$$(12) \quad \begin{aligned} (A \cdot U) &= / \text{ } \text{ } / \\ (U \cdot A) &= / \text{ } \text{ } / \end{aligned}$$

This will be crucial in our analysis of vowel coalescence, particularly in cases where the same input vowels derive different outputs.

We will apply this notion of operator and head in our analysis of coalescence. We follow Kaye et. al. 1985 in assuming that the head will be the starting point of all derivations and that the output segment will inherit all the features from this head except the ones that will be provided by the operator, which are the marked features represented in the uppercase. We, however, differ from government phonology concerning the position of the operator and the head. Instead of assuming a fixed ordering of the operator and the head, we will assume that the ordering will be determined by language specific parameters. Therefore, although the government phonology framework posits a fixed operator - head ordering, the following options are available in our theory:

- (13) a. OPERATOR HEAD (right-headed languages)
b. HEAD OPERATOR (left-headed languages)

Let us take a look at how this approach to vowel coalescence will merit us. In the examples in 14, we find that languages can be classified into two groups: the right-headed languages and the left-headed languages. The location of the head determines which group a language belongs to: in right-headed languages, fusion takes place in the direction from right to left, in the case of left-headed languages, from left to right. This difference in the direction of fusion leads to the systematic asymmetric relationships among the inputs and the outputs. Specifically, let us examine the examples from Arabic and Old Japanese:

(14)	Right-headed languages	Left-headed languages
	Arabic	Greek
	au > A · U > /o:/	ao > A · A · U > /ɔ:/
		oa > A · U · A > /ɔ/
	Old French	
	au > A · U > /o/	Kikuyu
	eau > A · I · A · U > /o/	ao > A · A · U > /ɔ/
	Old High German	Korean
	ai > A · I > /e:/	ai > A · I > /æ/
	au > A · U > /o:/	
	Sanskrit	Old Japanese
	au > A · U > /o:/	ia > I · A > /e/
	ai > A · I > /e:/	ua > U · A > /o/
		au > A · U > /ɔ/
	Spanish	
	ai > A · I > /e:/	
	au > A · U > /o:/	

When we compare the inputs for the Arabic and Old Japanese examples, we find that although the input elements are ordered as <A · U> in both cases, the output differs in these two languages. Whereas in Arabic, the inputs /au/ become [o:], in Old Japanese, the same vowel sequences /au/ derive the output [ɔ].

The examples from Old High German, Sanskrit and Korean also show cases where the same inputs derive different outputs. In Old High German and Sanskrit, the input elements <A · I> come out as [e:], but in the case of Korean, <A · I> becomes [æ].

Since we are comparing different languages here, it might be claimed that the dominant features for each language differs, and that this has led to the different outputs. However, if we consider examples from Old Japanese, we find that this alone is not adequate in determining the dominant factors in the process of coalescence.

In Old Japanese, there are examples where the same input elements differing in just their ordering, result in different outputs. The input ordering of the elements <U · A> results in [o], whereas the input <A · U> results in [ɔ]. If coalescence were to be captured by the use of the dominant features of the language alone, there is no accounting for the fact that the same inputs differing only in their ordering result in different outputs in the same language. In the case of Old Japanese, it is clear that the ordering of the head and operator is crucial in determining the output.

4. Conclusion

In this paper, we have claimed that in dealing with coalescence, the position of the head is crucial in deriving the outputs. Since the head will be the starting point at which all derivations start, the right-headed languages will derive the output by inheriting the features of the right input element save the marked feature of the operator element. In the case of left-headed languages, the derivation will start from the left element and the compounding of elements will take place in the direction from left to right.

By assuming such directionality in this process, it is possible to resolve some of the shortcomings of previous studies and to account for coalescence in a consistent way.

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